Opportunities for CCMC support of GEM Focus Groups

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NCAR/HAO

GEM Steering Committee Chair

Outline

- Background on GEM
  - Research Goals
  - Focus Groups

- Previous Experiences with Challenges
  - Reconnection Challenge
  - Storm/Substorm Challenge
  - GEM/CEDAR Challenge

- Future Plans

Geospace Environment Modeling Program

- Initiated in 1991 as NSF targeted research program with the goal
  - to understand the solar-terrestrial system well enough to be able to formulate a mathematical framework that can predict the deterministic properties of geospace ('weather in space') and the statistical characteristics of its stochastic properties ('climate in space').
- 2013 White Paper updated the vision and mission
  - Vision - Accurate prediction of the geospace environment
  - Mission - Develop physical understanding of the large-scale organization and dynamics of the geospace environment from observations, theory and increasingly realistic models

GEM Goals

- Develop an integrated physical understanding of the geospace dynamical system;
- Develop the scientific understanding of geospace processes required for accurate prediction;
- Advance modeling capabilities, **including metrics and validation** of first-principles and empirical models, and promote the broader use of models;
- Advance innovative observational capabilities, especially synoptic measurements including ground-based measurements, to improve scientific understanding, facilitate data assimilation and test key elements of models;
- Promote a vibrant community of geospace scientists to accomplish program goals; and
- Prepare and develop the next generation of geospace researchers

GEM Focus Groups I

- Tail-Inner Magnetosphere Interactions (2012-2016)
  - V. Angelopoulos, P. Brandt, J. Lyon, & F. Toffoletto
- Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures (2012 – 2016);
  - H. Zhang, Q.-G. Zong, M. Ruohoniemi, & D. Murr
- Magnetic Reconnection in the Magnetosphere (2013 – 2017)
  - P. Cassak, A. Runov, Y. Liu, and B. Walsh
- Storm-Time Inner Magnetosphere-Ionosphere Convection (2013 – 2017)
  - J. Baker, M. Ruohoniemi, S. Sazykin, P, Chi, and M. Engebretson
- Geospace Systems Science (2014 – 2018)
  - J. Borovsky, W. Lotko, V. Uritsky, & Juan Valdivia
- Inner Magnetosphere Cross-Energy/Population Interactions (2014 – 2018)
  - Y. Yu, C. Lemon, M. Liemohn, and J. Zhang; RA
- Quantitative Assessment of Radiation Belt Modeling (2014 – 2018)
  - J. Albert, W. Li, S. Morley, and W. Tu

GEM Focus Groups II

- Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms (2015 – 2019)
  - T. Nishimura, K. Murphy, E. Spanswick, and J. Yang
- Tail Environment and Dynamics at Lunar Distances (2015 – 2019);
  - C. P. Wang, A. Runov, D. Sibeck, V. Merkin, and Y. Lin
- Merged Modeling & Measurement of Injection Ionospheric Plasma into the Magnetosphere (M^3I^2) and Its Effects -- Plasma Sheet, Ring Current, Substorm Dynamics (2016 – 2020)
  - V. Eccles, S. Zou, and B. Giles
- ULF Wave Modeling, Effects, and Applications (2016 – 2020)
  - M. Hartinger, K. Takahashi, and B. Kress
- Modeling Methods and Validation (2016 – 2020)
  - K. Garcia-Sage, M. Liemohn, L. Rastaetter, and R. Redmon
- Dayside Kinetic Processes in Global Solar Wind-Magnetosphere Interaction (2016 – 2020)
  - H. Hietala, X. Blanco-Cano, G. Toth, and A. Dimmock

First GEM Challenge
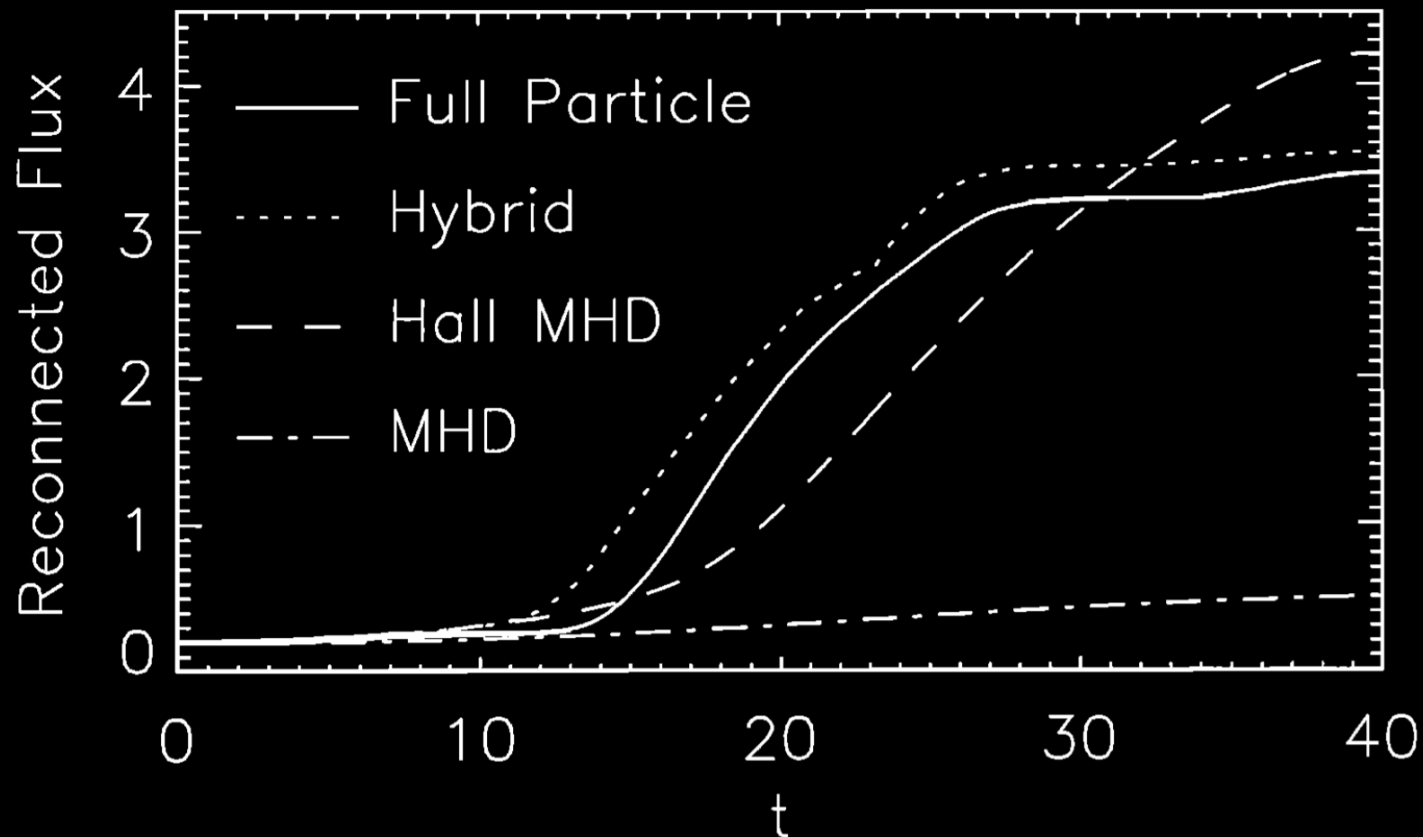
- GEM Magnetic Reconnection Challenge
  - One GEM's most highly cited papers (632)
  - Showed the utility of having different models solve the same problem

Metrics and Validation Challenges

Technical Paper

Geospace environment modeling 2008–2009 challenge: D_{st} index

L. Rastätter, M. M. Kuznetsova, A. Glocer, D. Welling, X. Meng, J. Raeder, M. Wiltberger, V. K. Jordanova, Y. Yu, S. Zaharia, R. S. Weigel, S. Sazykin, R. Boynton, H. Wei, V. Eccles, W. Horton, M. L. Mays, J. Gannon

Corresponding author: L. Rastätter, Space Weather Laboratory, Code 674, NASA Goddard Space F... Greenbelt, MD 20770, USA. (lutz.rastaetter@nasa.gov)

Technical Paper

Community-wide validation of geospace model ground magnetic field perturbation predictions to support model transition to operations

A. Pulkkinen, L. Rastätter, M. Kuznetsova, H. Singer, C. Balch, D. Weimer, G. Toth, A. Ridley, T. Gombosi, M. Wiltberger, J. Raeder, R. Weigel

Corresponding author: A. Pulkkinen, The Catholic University of America, Physics Department, 620 Michigan Ave, NE, Washington, DC 20064, USA. (antti.a.pulkkinen@nasa.gov)

Recent and Current Challenges I

- Magnetopause Modeling Challenge
  - Compared simulation results with predictions of MP position from Shue et al. 1998 MP Model
  - Extended to comparison with satellite crossings
  - Sponsored by Metrics and Validation FG
- ULF Wave Modeling Challenge
  - Can global models reproduce ULF waves in MS?
  - Can those waves drive radiation belt response during March 2013
  - Sponsored by the M&V and RB & Wave Modeling FG

Recent and Current Challenges I

- GEM-CEDAR Modeling Challenge
  - Selected a series of storm intervals for inter-model comparison
  - Focuses included NmF2, HmF2, neutral winds, TEC, and temperatures
  - Supported by both GEM and CEDAR communities

Future Collaborations

- New FG – Modeling, Methods, and Validations
  - Under leadership of K. Garcia-Sage, M. Liemohn, L. Rastaetter, and R. Redmon
  - Key topics for future validation studies include
    - Plasma validation making use of MMS, RBSP, and THEMIS plasma data for increasing model reliability and our understanding of the physical processes leading to certain types of plasma structures and velocity space distributions
    - Magnetopause validation for both reconnection physics and magnetopause shadowing in energetic particle transport
    - Ionospheric conductance carrying out validation of precipitation and conductance models and assessing global effects

Conclusions

- GEM has a long history of using challenge type events to advance is goal enabling better prediction of the magnetosphere

- CCMC has contributed significantly to several recent metric and validation challenges

- We look forward to continued collaboration with CCMC on challenges that address the key topics identified by the new MMV FG